SCIENCE

Level

F	1	2	3	4	5	6	B6

Properties of materials before and after change

Strand
Natural and Processed Materials

Key concept
Patterns of interactions between materials can be identified and used to predict and control further interactions.

Purpose

Activities in this module are designed to help students understand that the properties of materials after a change may be different from the properties before a change. Students have opportunities to:

- make and judge observations of materials before and after changes occur;
- explore changes to materials;
- hypothesise about the changes that have occurred;
- identify and control variables affecting changes to materials as they conduct investigations;
- communicate understandings using illustrations, descriptions and reports.

Overview of activities

The following table shows the activities in this module and the way in which these are organised in **introductory**, **developmental** and **culminating** phases.

Introductory ►	Developmental ►	Culminating
Under the lens — dissolving crystals	Viscosity	Plaster of Paris models
The waking of Edward Bear	Burning	
	Soaking up liquids	
	Paper chromatography	
	O°C isn't always freezing	
	Unusual fluids	

QUEENSLAND SCHOOL CURRICULUM COUNCIL

Core learning outcomes

This module focuses on the following core learning outcomes from the Years 1 to 10 Science Syllabus:

Natural and Processed Materials

2.2 Students recognise ways in which changes in properties of familiar materials occur (including temperature change and magnetism).

3.2 Students compare properties of materials before and after physical and chemical changes.

Core content

This module incorporates the following core content from the syllabus:

Natural and Processed Materials

Nature of change

- requires heat/releases heat
- physical (change of state: melting/freezing)
- chemical (combustion, precipitation)

Causes of change

- heating/cooling
- oxidising — burning

Assessment strategy

Suggestions for gathering information about student learning are provided in each of the activities in this module. Once sufficient information has been collected, judgments can be made about students' demonstrations of outcomes. Typical demonstrations of this module's intended outcomes are provided here to indicate the pattern of behaviour to look for when making judgments.

Natural and Processed Materials

2.2 Students recognise ways in which changes in properties of familiar materials occur (including temperature change and magnetism).

Students may:

- identify ways in which materials can be changed;
- describe an experiment that demonstrates a change in the properties of materials;
- describe patterns in changes in properties of familiar materials.

Natural and Processed Materials

3.2 Students compare properties of materials before and after physical and chemical changes.

Students may:

- identify physical changes that influence properties of materials;
- describe evidence that a chemical change has occurred;
- describe the effects of water on different types of paper;
- investigate the separation of dyes into their component colours.

Background information

Current scientific conceptions

Physical change

A physical change is a change in the form or physical properties of a substance but not in its chemical composition. For example, processes of evaporation, condensation, solidification, melting, wetting and drying change the form of a substance. Heating and cooling change the temperature of a substance.

Chemical change

A chemical change occurs when the atoms of the original substance or substances are recombined to form a new substance or new substances. For example, cooking and decomposition reactions involve creating new combinations of atoms.

Properties before and after change

Investigating the properties of substances undergoing change involves:

- comparing the properties of the original substance(s) with those of the final product(s);
- determining whether the properties of the product(s) are a combination of the original properties or completely different.

Capillary action

Capillary action is the movement of water or any liquid up a very fine tube. In paper and other fibrous materials, the fibres lying side by side have a very fine space (tube) between them. It is through these spaces that liquids move.

Students' prior understandings

Some students may believe that:

- when crystals are dissolved, the material from which they are made ceases to exist;
- all liquids become thinner when stirred or heated;
- all paper has the same degree of absorbency.

Teachers can help students broaden their understandings by encouraging them to investigate a variety of materials and the ways in which these can be changed.

Terminology

Terms associated with physical and chemical changes are essential to the activities in this module — for example:

absorption	evaporation	saturate
capillary	filter paper	solution
chromatography	fire resistant	temperature
crystal	flammable	thermometer
density	freezing point	viscosity
dissolve		

Students may already be familiar with some of these terms and understand their meanings and use in scientific contexts. If so, the activities in this module will provide opportunities for them to evaluate current usage. If not, these activities will provide opportunities for students to develop their understandings.

Cooperative learning — working in groups

Many of the activities in this module are best conducted in small groups. When students are working in groups, there should be a focus on cooperative learning. Information about cooperative learning is provided in the sourcebook guidelines, appendix 2.

School authority policies

Teachers need to be aware of and observe school authority policies that may be relevant to this module.

Safety policies are of particular relevance to the activities that follow. It is essential that demonstrations and student activities are conducted according to procedures developed through appropriate risk assessments at the school.

In this module, teachers must consider safety issues relating to:

- heating materials;
- burning materials;
- using chemicals.

Support materials and references

Thurman, R. 1997, *On the Spot Science and Technology*, Level 1, Addison Wesley Longman Australia, Melbourne.

VanCleave, J. 1993, *Janice VanCleave's Molecules: Spectacular Science Projects*, John Wiley & Sons Inc., New York.

Victorian Department of Education 1999, *ScienceScope 1: Units of Work for the Early Years*, Addison Wesley Longman Australia, Melbourne.

ACTIVITY

Under the lens — dissolving crystals

Introductory

Focus

This activity provides opportunities for students to observe the properties of crystalline materials and the changes caused by dissolving.

Materials

For each group:

- crystals of various salts such as sodium chloride (table salt), magnesium sulfate (Epsom salts) and copper sulfate
- crystals of various sugars such as sucrose (e.g. raw sugar) and glucose (e.g. crystallised honey)
- sheet of black cardboard
- illuminated loupe/hand lens/magnifying glass/stereo dissecting microscope with above or incident light
- teaspoons
- water
- dropper
- 250 mL beakers
- stirrers

Teaching considerations

Practical points

Assist students by modelling the use of an illuminated loupe and stereo dissecting microscope (where available). Allow them to explore how to use the equipment by observing classroom materials including clothing, print, carpet and other interesting textures.

If students are going to investigate more than one type of crystal, they should use a clean, dry teaspoon for each substance. This will prevent contamination of the samples.

Students with vision impairment

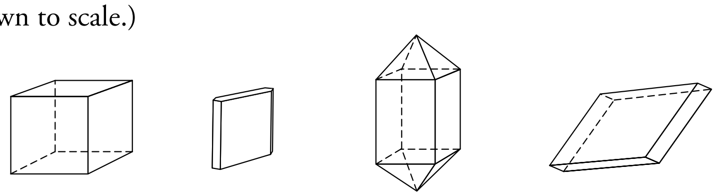
Some students with vision impairment may require assistance for this activity. Seek advice from their support teacher.

Working scientifically

Making and judging observations
Measuring
Performing investigations
Constructing meaning
Discussing thinking

Time: 60 minutes

▶ In groups, students use magnifying equipment to examine crystals of various salts and sugars on black cardboard. They observe size, shape and colour of the crystals and record and illustrate their observations. The following diagrams show the shapes of typical crystals. (The diagrams are not drawn to scale.)



Salt **Sugar** **Epsom salts** **Copper sulfate**

The follow-up discussion of findings could include questions such as:

- Were the crystals of the various salts all the same size, shape and colour?
- Were all the crystals of copper sulfate the same size, shape and colour?
- Were the crystals of the various sugars the same size, shape and colour?
- Were the salt crystals the same as the sugar crystals?

▶ Students predict how the crystals will change when water is added. They make suggestions about what happens to a substance when it is put in water and 'disappears'. Students suggest a definition for 'dissolve'. They place a drop of water on one or two crystals, observe the changes and record the information including illustrations where appropriate.

▶ Students dissolve one teaspoon of one type of crystal in 150 mL of water and record the changes. They discuss and test techniques to speed up the dissolving process — for example, heating, stirring, shaking, or grinding the crystals into smaller pieces.

▶ Students take one of the salts or sugars and investigate how much of it will dissolve in 150 mL of water. The teacher introduces the term 'saturated solution'. Students then saturate a small sample of their solution and describe the contents of the beaker. They discuss the results and suggest answers (with explanations) to the following questions:

- Are the crystals of some substances easier to dissolve than others?
- Do all saturated solutions have the same amount of material dissolved in them?

▶ Students suggest ways of recovering the crystals from the solution and test their ideas. Once they have recovered some crystals, students observe whether these crystals are the same size, shape and colour as the original ones.

▶ Students record their understandings about dissolving in words and/or pictures.

Additional learning

▶ Students collect information about the use of substances such as mineral turpentine and methylated spirits to clean things because not everything dissolves in water.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' records of information and illustrations.

ACTIVITY

The waking of Edward Bear

Introductory

Focus

This activity provides opportunities for students to develop an understanding of changes in materials resulting from capillary action.

Materials

- newspaper
- scissors
- shallow container of water

Teaching considerations

Story of Edward Bear

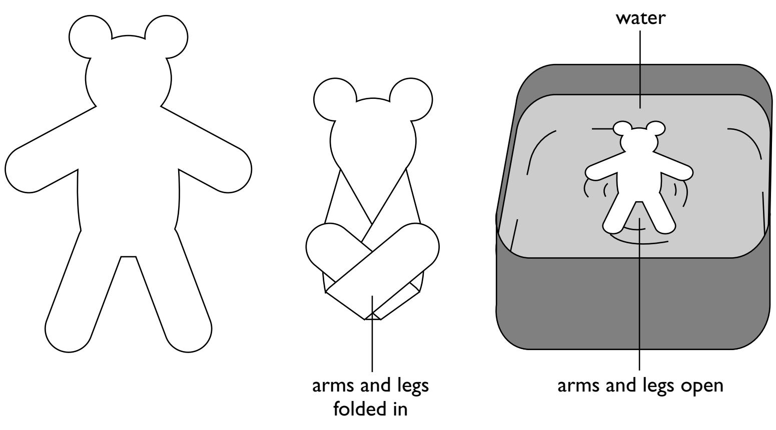
This activity is based on the story below. A newspaper cut-out represents the character of Edward Bear. Tell the story with appropriate actions and discuss with students the changes that occur.

> *Edward Bear is asleep in a cave where he has been hibernating all winter. He resists his mother's attempts to wake him so she takes him to the lake and gently places him on the water. Immediately he awakes. His arms and legs open wide.*

Invite students to suggest shapes for similar demonstrations of capillary action. For example, flower shapes with coloured-in petals would further model the coming of spring and the end of Edward's hibernation period. Although this activity is a teacher demonstration, students could follow the same process using these other shapes.

Making Edward Bear

Cut Edward Bear out of newspaper, fold and place in water as shown below. The cut-out should be a typical teddy bear shape with fairly short arms and legs. Small bears work much better than large bears.



What happens to Edward Bear?

When Edward Bear is floated on water, he 'wakes' very quickly. Water is drawn by capillary action into the matrix of fibres in the paper. This causes the paper to expand, which in turn causes the arms and legs to spring open. Water drawn by capillary action into very narrow spaces travels great distances and against gravity. This occurs, for example, when a towel on the edge of the bath becomes completely wet from having just one corner in the water.

PROPERTIES OF MATERIALS BEFORE AND AFTER CHANGE • MIDDLE PRIMARY

Working scientifically

Time: 20 minutes

Constructing meaning
Discussing thinking
Listening and questioning

▶ Students view the demonstration of Edward Bear's waking. They discuss what has occurred and suggest reasons for the changed appearance of the bear. The teacher introduces the concept of capillary action. Discussion questions could include:

- How did Edward Bear appear before he was placed on water?
- What changed?
- How did Edward 'wake up'?
- How did the water move through the paper?
- What did the water do that made Edward 'wake up'?

Additional learning

▶ Students try to 'wake' Edward Bear (or another cut-out) a second time. They should find this unsuccessful because the paper will be waterlogged with no capacity for further capillary action. Students could discuss changes the paper has undergone as a result of water penetrating the fibrous material.

▶ Students try using different types of paper to make Edward Bear.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions.

ACTIVITY

Viscosity

Developmental

Focus

This activity provides opportunities for students to observe how physical and chemical changes can alter viscosity.

Materials

For each group:

- approximately 10 mL each of:
  - honey
  - water
  - oil
- 1 tablespoon of butter
- ice cube
- small cubes of Plasticine
- small rock
- slab of timber (20–30 cm long) and blocks to make a ramp
- candle and matches (only if requested)

For the teacher:

- Resource Sheet 1, 'Making toffee' (optional)
- ingredients for making toffee listed on Resource Sheet 1 (optional)

Teaching considerations

Viscosity

Viscosity relates to the ease with which a fluid moves. Heating or cooling can change the viscosity of some materials.

Investigations

Students' investigations involve the use of ramps to test the viscosity of various materials. All ramps should be similar in surface, length and elevation so that groups can compare results.

Students may heat materials as part of their investigations. Have candles and matches on hand for this purpose.

Resource Sheet 1

The investigation suggested here is based only on physical changes to materials. Students could investigate chemical changes that alter viscosity by observing toffee being made from a sugar solution. This should be done as a teacher demonstration. A recipe for making toffee is provided on Resource Sheet 1.

Fair tests

The investigation will prepare students for demonstration of Science and Society core learning outcome 4.2, 'Students use the elements of a fair test when considering the design of their investigations'.

Safety

Inform students about safe practices for heating materials.

Working scientifically

Time: 60 minutes

Engaging with problems
Handling materials
Looking for patterns and meanings
Measuring
Performing experiments
Seeking reasons
Making comparisons
Suggesting
Discussing thinking
Illustrating
Relating

▶ The teacher introduces the term 'viscosity' and asks students to suggest examples of fluids with similar or different viscosities.

▶ In groups, students investigate the viscosity of the following materials: honey, water, oil, butter, ice, Plasticine, and a small rock. They time how long it takes each material to travel a set distance down a ramp and record the results in a table like the one below. (At this stage, students complete only the first three columns.)

Testing viscosity

Material	Illustration	Test 1 (seconds)	Physical or chemical change made to the material and how this assists movement	Illustration (where material has changed)	Test 2 (seconds)

▶ Students compare the ability of the materials to travel down the ramp and relate this to the state of matter and viscosity of the materials. They then discuss methods of facilitating the movement of the materials. Discussion questions could include:

- Which state of matter is not able to flow?
- Which materials could not be changed to make them flow down the ramp?
- How could each of the materials be changed to increase its 'runniness'?
- Are these changes chemical or physical changes?
- Why would it be useful to reduce viscosity and make fluids flow more easily?
- In what situation might it be useful to increase the viscosity of a fluid?

▶ Students alter the materials as discussed and repeat the tests. They record results in the table, along with brief descriptions of the changes and how these affected viscosity. Where appropriate, students should include illustrations showing the changed appearance of the materials.

Additional learning

▶ Students describe each of the ingredients used to make toffee, observe toffee being made and describe changes that occur. They then discuss the characteristics of physical and chemical changes and decide whether the changes observed were chemical or physical.

Gathering information about student learning

- students' contributions to discussions;
- students' tables;
- students' descriptions and illustrations.

ACTIVITY

Burning

Developmental

Focus

This activity provides opportunities for students to develop an understanding of chemical changes that occur when various materials burn.

Materials

For each group:

- small pieces of fabric made from both natural and synthetic fibres (e.g. pieces of curtain material, singlets, woollen blankets)
- candle
- matches
- tongs
- containers of water (to be placed beside candles)

Teaching considerations

Burning materials

The burning of materials in this activity may be carried out by students under careful supervision, or presented as a teacher demonstration.

Because many artificial fibres melt quickly and produce molten drops, the burning materials should be held over water. Place containers of water beside candles for this purpose.

Safety

Inform students about safe practices for burning materials in an investigation — for example:

- Burn only a small amount of material in a well-ventilated area.
- Exercise care in smelling as some fumes are irritants.
- Carry out risk assessment and risk management related to the use of a naked flame.

Working scientifically

Designing and performing investigations
Exploring phenomena
Handling materials
Looking for patterns and meanings
Making observations
Predicting
Drawing conclusions
Making comparisons
Creating presentations
Discussing thinking

Time: 45 minutes

▶ Students discuss what burning is, the products of burning, and how the nature of the material being burnt is related to the products of burning.

▶ In groups, students sort materials into natural fibres and synthetic fibres. They predict the effects of burning each of the materials. Discussion questions could include:

- Which fibres do you think are flammable?
- Which fibres do you think are fire-resistant?
- Which fibres burn faster than others?
- What are some observations you could make as the materials burn?

▶ Students discuss how to test their ideas, what they must do to ensure tests are fair, and how to record their observations — for example, in a table like the one on the next page:

Investigating how materials change when burnt

Material	How easily it burns	Size of flame	Colour of flame	Colour of smoke	Odour of smoke

▶ Students conduct their tests. Using tongs, they take turns to hold a piece of fabric over the candle flame until it catches alight and then over the container of water to catch any drips or hot ash. Students identify the type of fabric and record their observations of each burning. Questions for the follow-up discussion could include:

- What did you see and hear as the fabric burnt?
- What remained after the fabric was burnt?
- When the fabrics were burnt, which new substances were produced?
- When the fabrics were burnt, which change (physical or chemical) took place?
- When the burnt fabric was cool, how did it look, smell and feel?
- Is there a difference between burning natural and synthetic fibres?
- Why is it recommended that people do not sit near heaters, radiators and naked flames?
- For which items of clothing would it be safer to use natural fibres?
- What recommendations for winter clothing can you make?

▶ Students discuss the difference between physical and chemical changes and the type of change involved in burning.

▶ Students create presentations about the properties of materials before and after burning, including an explanation of what they believe occurs.

Additional learning

▶ Students examine articles of clothing at home looking for and recording information about flammability on labels. In particular, they could check labels on baby and toddler clothes and discuss their findings.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' predictions, hypotheses and observations;
- students' presentations.

ACTIVITY

Soaking up liquids

Developmental

Focus

This activity provides opportunities for students to investigate water absorption in paper and the changes this causes to the properties of paper.

Materials

For each group:

- various types of paper (e.g. bond paper, kitchen towels, tissues, blotting paper, newspaper)
- beakers
- water
- ballpoint pen

For each student:

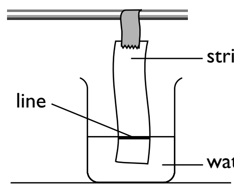
- 2 copies of the planning and reporting worksheets chosen for the activity (see the sourcebook guidelines, appendix 3)

Teaching considerations

Water absorption

The investigation in this activity requires a method of observing paper absorb water. The following is a procedure for doing this:

- Draw a line with a ballpoint pen 1 cm from the end of a strip of paper.
- Suspend the paper over a beaker containing 150 mL of water so that the water comes up to the line.
- Observe the progress of the water up the strip.



Water drawn by capillary action into very narrow spaces can travel great distances and against gravity.

Planning investigations

Show students how to prepare the equipment for their investigations and then allow them to decide how to perform the tests and gather information. The planning and reporting worksheets provide assistance with planning the investigations.

Fair tests

The investigation will prepare students for demonstration of Science and Society core learning outcome 4.2, 'Students use the elements of a fair test when considering the design of their investigations'.

Working scientifically

Time: Part 1, 30 minutes; Part 2, 30 minutes

Designing and performing investigations

Identifying and controlling variables

► Students identify various kinds of materials (including paper) that are used to soak up liquids. They are then challenged to:

- find out the most absorbent paper among the range provided for the activity;
- report on the changes that water causes to various kinds of paper.

Making and judging observations
Drawing conclusions
Interpreting data
Making comparisons
Summarising and reporting

Part 1: Absorbency

▶ Students discuss ways of investigating the absorbency of paper. Discussion questions could include:

- What does 'absorbency' mean? Is it the amount of water the paper can soak up or the rate at which water is soaked up?
- How could the amount of water soaked up by the paper be measured?
- How could the rate of water being soaked up be measured?

▶ In groups, students design investigations using the planning and reporting worksheets in the sourcebook guidelines as a reference.

▶ Students perform the investigations in groups and compile individual reports. (They need to keep the pieces of paper used in their investigations for the second part of the activity.)

Part 2: Changes caused by water

▶ Students discuss ways of investigating changes that water causes to paper. Changes to be investigated could include strength and texture of the paper and whether writing on wet paper is readable.

▶ In groups, students design their investigations using the planning and reporting worksheets in the sourcebook guidelines as a reference.

▶ Students perform the investigation in groups and compile individual reports.

Additional learning

▶ Students investigate the effects of the width and shape of a strip of paper on the rate of water absorbency.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' completed planning and reporting worksheets.

ACTIVITY

Paper chromatography

Developmental

Focus

This activity provides opportunities for students to compare the solubility of pigments in different solvents.

Materials

For each group:

- blotting paper (or absorbent kitchen paper)
- filter paper
- pencil
- water-soluble felt pen (black)
- beakers
- water
- ruler
- permanent marking pen (black)
- methylated spirits
- water-soluble felt pens of various colours (optional)
- food colouring (optional)
- water-soluble paints (optional)

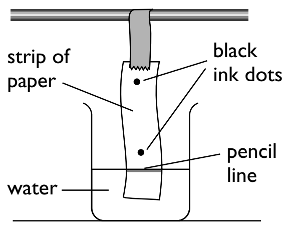
Teaching considerations

Paper chromatography

Students can choose either of the following methods of paper chromatography. (Pencil should be used for any labels put on the chromatography paper.)

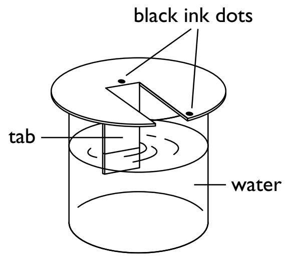
Method 1

1. Take a strip of blotting paper or absorbent kitchen paper 2 cm x 15 cm.
2. Draw a pencil line 2 cm from the end. This line will be placed on the water level.
3. Using a water-soluble black felt pen, place a dot 2 cm above the line and another at the top of the strip to record the original colour of the ink.
4. Place the paper in a beaker with sufficient water to reach the pencil line.



Method 2

1. Take a filter paper and place a dot of black ink in the centre of the paper.
2. Place another dot for colour reference on the outside edge of the paper. Then cut a strip towards the centre of the paper.
3. Fold down the strip and rest the paper on a beaker of water so that the strip reaches into the water, but the ink dot remains out of the water.



Changes that occur in paper chromatography

Water and other solvents travel through absorbent paper by capillary action. Capillary action causes liquids to move great distances and against the force of gravity. This capillary action occurs only where the spaces between fibres are very narrow or in very narrow tubes. It will not happen, for example, in wide drinking straws.

Ink is a soluble substance often made of various component colours. When water or another solvent causes ink on paper to 'run', each component colour dissolves at its own characteristic rate. One colour in the mixture will dissolve more readily than another and be carried away from the original ink mark first (in this activity, the black dot). Other colours that dissolve less readily will travel more slowly. The result is a rainbow effect emanating from the original ink. Although students may think that new substances have been produced (for example, red, green and blue inks), the colours were just mixed together and have now been separated by the physical process of dissolving. The changes in paper chromatography are physical changes, not chemical changes.

Students with vision impairment

Some students with vision impairment may need assistance for this activity. Seek advice from their support teacher.

Working scientifically

Time: 45 minutes

Exploring phenomena
Making and judging observations
Predicting
Making comparisons
Discussing thinking

▶ Students discuss how colour pigments are combined to produce different colours, and why colours that are made up of two or more different colours are difficult to reproduce exactly. They predict the colours that make up black.

▶ In groups, students test their predictions using one or both of the methods suggested in 'Teaching considerations'. They observe the water travelling up the paper until it reaches the ink dot. After a reasonable separation of colours has occurred (time allowed for this should be the same for all groups), students measure the distance each colour has travelled from the starting point. Students share information and discuss whether a pattern can be identified in the distances the various colours have travelled.

▶ Students discuss their ideas about why the phenomenon of colour separation occurs. Questions to guide discussion could include:

- Why is the water able to move through the paper?
- What is happening to the original dot of colour?
- What has caused the colours to separate?
- Why have some colours moved further than others?
- Are the changes that are occurring physical or chemical?

▶ Students observe the effects of different solvents on different inks — for example, water on permanent ink; methylated spirits on water-soluble ink; methylated spirits on permanent ink.

▶ Students discuss and compare the solubility of the inks and the component colours of permanent and water-soluble colours.

Additional learning

▶ Students compare:

- the range of pigments in different coloured, water-soluble pens;
- the pigments in food colouring and water-soluble paints.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' observations and comparisons.

ACTIVITY

0°C isn't always freezing

Developmental

Focus

This activity provides opportunities for students to compare the properties of water with the properties of solutions.

Materials

For each group:

- ice cubes
- beakers or jars
- salt
- sugar and other substances commonly used to make solutions (e.g. vinegar, alcohol)
- stirrers
- thermometer

For each student:

- planning and reporting worksheets (see the sourcebook guidelines, appendix 3)

Teaching considerations

Comparing temperature changes in ice-water mixtures

For this activity, students need to determine a method of comparing temperature changes in ice-water mixtures. The following is a basic procedure:

1. Record the initial temperature of the ice-water mixture. (It should be 0°–1°C.)
2. Record the temperature every five minutes for the next twenty minutes.
3. To another similar ice-water mixture add several teaspoons of salt or other substance being tested.
4. Stir the mixture and record the temperature. (It should be less than 0°C.)
5. Record the temperatures every five minutes over a twenty-minute period.

Working scientifically

Designing and performing investigations
Engaging with problems
Exploring phenomena
Generalising
Making links
Discussing thinking

Time: 45 minutes

▶ Students discuss what ice is and create a word wheel centred around 'freezing' (see the initial in-service materials, pp. 38–39). Words or terms could include snow, 0° Celsius, iceblocks and other things that freeze.

▶ Students discuss their ideas about whether the freezing point of water can be changed.

▶ In groups, students design and perform an investigation into the temperature changes that occur in an ice-water mixture when salt is added. They may find the planning and reporting worksheets in the sourcebook guidelines useful for structuring their investigations and recording findings. Students select their own methods of recording and presenting data.

▶ Students investigate whether adding sugar or other soluble substances (for example, vinegar, alcohol) to an ice-water mixture has any effect on the freezing point of the solution. They then discuss possible generalisations about the temperatures at which solutions freeze.

▶ Students relate their findings to real situations or practices — for example:

- In snowy conditions, salt is spread on roads to reduce the temperature at which water freezes, and alcohol is put in car radiators to prevent them from freezing.
- Iceblocks made with too much sugar are difficult to freeze and melt very quickly.

Additional learning

▶ Students design and perform an investigation to find out if the amount of salt added to water influences the temperature at which a salt solution freezes.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' generalisations;
- students' completed planning and reporting worksheets.

ACTIVITY

Unusual fluids

Developmental

Focus

This activity provides opportunities for students to investigate changes to a range of materials that exhibit unexpected properties in particular circumstances.

Materials

For each group:

- cornflour
- water
- paper cups
- wooden stirrers
- toothpaste
- tomato sauce
- borax
- polyvinyl acetate (PVA) glue
- food colouring
- spoon
- paper towels

Teaching considerations

'Fluid' is a term used to describe a substance that is capable of flowing — that is, a liquid or a gas. Solids are not included in the category 'fluids'. However, there are some materials that behave like a solid in some conditions and a fluid in others. Many of these materials are used regularly in everyday life and in the preparation of foods, cosmetics, paints and other household materials.

Stir-thinning fluids

Some materials behave as solids until a particular force is applied, which causes them to flow. For example, toothpaste is a solid in the tube and on a toothbrush, but it flows out of an open tube when squeezed; peanut butter appears to be a solid until a knife applies a force to spread it; and tomato sauce thins when shaken. Materials that are apparently solid but appear to behave as a fluid when a force is applied are called stir-thinning fluids. The force changes the shape of the material rather than its position.

Stir-thickening fluids

A mixture of cornflour and water behaves in the opposite way to materials such as toothpaste and peanut butter. When the cornflour-and-water mixture is stirred, a force is applied, and it becomes thicker. The more quickly the mixture is stirred, the thicker it becomes. This type of mixture is known as a stir-thickening fluid.

'Slime'

'Slime' is a polymer made up of polyvinyl acetate cross-linked with borax. Slime is another material that exhibits properties of both solids and fluids. It can be made in the following way:

- Place a teaspoon of borax into a plastic cup, half fill the cup with water and stir to dissolve the borax.
- In another plastic cup, put a quarter of a cup of PVA glue and add some food colouring.
- Slowly add the borax solution to the PVA solution and stir until slime forms.
- Remove the slime with a spoon and wash it to remove the excess food colouring. Dry the slime on a paper towel.

Safety

Students must wash their hands to avoid contaminating materials and ingesting borax.

Working scientifically

Time: 60 minutes

Handling materials
Making observations
Playing
Predicting
Formulating and elaborating ideas
Making comparisons
Creating presentations
Summarising and reporting

▶ Students clarify their ideas about the characteristics of solids, liquids and gases and make links between these ideas and their understandings of the term 'fluid'. They identify some materials that may be difficult to categorise clearly as either 'solid' or 'fluid' and discuss features that make categorisation difficult.

▶ In groups, students explore an unusual fluid. They place two tablespoons of cornflour in a paper cup, gradually add water, and stir until a stiff paste forms. They observe that when they stir the mixture slowly, it acts like a liquid but when they stir quickly, it acts like a solid (a stir-thickening fluid). Students remove the paste from the cup and roll it into a ball. They observe that while they keep it moving, it stays as a ball but as soon as they stop, it will flow through their fingers. Students write comparisons of:

– the **materials** before and after mixing;
– the **mixture** when it is stirred slowly and quickly.

▶ Students predict and observe the effect of stirring toothpaste and tomato sauce. They then write brief comparisons of the properties of each substance at rest and when stirred, and suggest other substances that act in a similar way.

▶ In groups, students make slime and then share their observations in the class group. The follow-up class discussion should focus on changes that occurred as the slime was made and reasons for the changes. Discussion starters could include:

- What happened to the PVA glue as the borax was added?
- What happened if too much borax was added?
- Describe the borax solution and the PVA glue before they were mixed.
- Describe the slime you have made.
- What do you think has happened to cause the changes?
- Was the change physical or chemical?
- What happened to the slime when a force was applied?
- What happened to the slime when no force was applied?
- Is slime a fluid?
- Is it a stir-thinning or a stir-thickening fluid?

▶ Students create presentations about the properties of stir-thinning and stir-thickening fluids.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' predictions and observations;
- students' presentations.

ACTIVITY

Plaster of Paris models

Culminating

Focus

This activity provides opportunities for students to compare the properties of plaster of Paris models made under different conditions.

Materials

For each group:

- plaster of Paris
- water
- plastic container for mixing
- spatula or wooden stirrer
- frame for holding plaster model to dry
- additives such as pebbles (as used in aquariums) and coarse sand (both additives optional)
- magnifying glass
- digital thermometer with probe or alcohol thermometer (optional)

Teaching considerations

Chemical change

When plaster of Paris and water are mixed, a new material is formed. Heat is created during this process, indicating a chemical change. If thermometers are available, students can measure the temperature change. Encourage students to use a magnifying glass to investigate the nature of the materials before and after mixing.

Changing the product

The relative amounts of water and plaster of Paris in the mixture can be altered to change the product. Additives such as pebbles or coarse sand can be included to show the comparative density of the material of the matrix in different samples. Students may have experience in making plaster of Paris models. If so, they could explore the effects of further changes to the product, such as painting, applying lacquer, chiselling and heating in an oven.

Fair tests

The investigation in this activity will prepare students for demonstration of Science and Society core learning outcome 4.2, 'Students use the elements of a fair test when considering the design of their investigations'.

Working scientifically

Time: 45 minutes for discussion and making models; 30 minutes to test models and report

Designing and performing investigations
Identifying and controlling variables
Making and judging observations
Examining and evaluating

▶ Students suggest examples of familiar materials that change when water is added. For example, flour and water form dough or glue.

▶ Students consider the materials provided for the activity and predict what will happen when water is added to the plaster of Paris. They identify the variables involved in making a plaster of Paris model (for example, amounts of water and plaster of Paris, rate of drying) and discuss ways of investigating the effects of changing variables.

Making comparisons
Creating presentations
Discussing thinking
Summarising and reporting

Discussion questions could include:

- What proportions of water and plaster of Paris should be used?
- What do you think will happen if more (or less) water is used?
- How could this be tested?
- How could different rates of drying be tested?
- Which criteria (crystal size, hardness, smoothness of surface, uniform texture) could be used to evaluate the plaster models?
- What will be the effect of adding materials such as sand or pebbles?

▶ In groups, students select a variable to investigate and then design and perform the investigation.

▶ Students prepare and present reports on their investigations. Reports should include a suggestion about the type of change that occurred (physical or chemical) with an explanation or a justification.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' reports.

Making toffee

Resource Sheet 1

Ingredients

- 175 g castor sugar
- 250 mL water

Method

1. Put the water and sugar in a small stainless steel pan. Heat at low temperature, stirring occasionally to dissolve the sugar.
2. Once the sugar has dissolved, increase the heat and boil rapidly until the syrup starts to brown.
3. Lower the heat and continue cooking, swirling the pan once or twice so that the syrup colours evenly. Do not allow the syrup to go too dark because it becomes increasingly bitter as the temperature rises and the colour darkens.
4. Pour into a mould and allow to cool.

Acknowledgments

This module is based on material developed by Christine Bennett who attended a module writing workshop organised by the Science Teachers' Association of Queensland and the Queensland School Curriculum Council.

This sourcebook module should be read in conjunction with the following Queensland School Curriculum Council materials:

Years 1 to 10 Science Syllabus

Years 1 to 10 Science Sourcebook: Guidelines

Science Initial In-service Materials

ISBN 0 7345 2004 2

Any inquiries should be addressed to:
Queensland School Curriculum Council
PO Box 317
Brisbane Albert Street, Q 4002
Australia

Telephone: (07) 3237 0794
Facsimile: (07) 3237 1285
Website: http://www.qscc.qld.edu.au
Email: inquiries@qscc.qld.edu.au

Illustrations by Stephen Francis

PIP 99157